

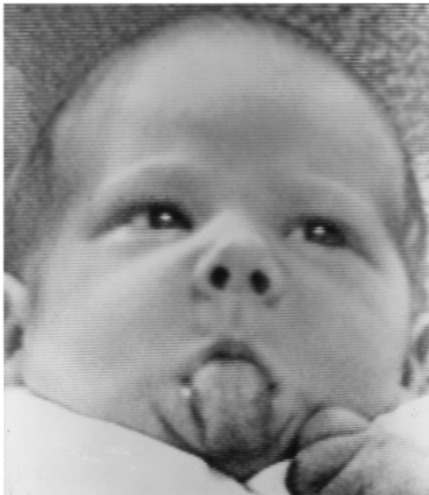
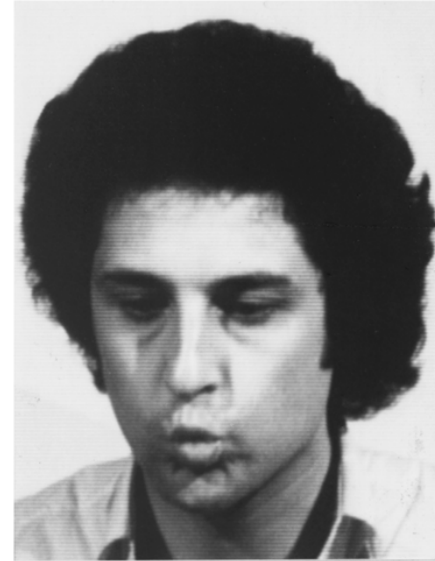
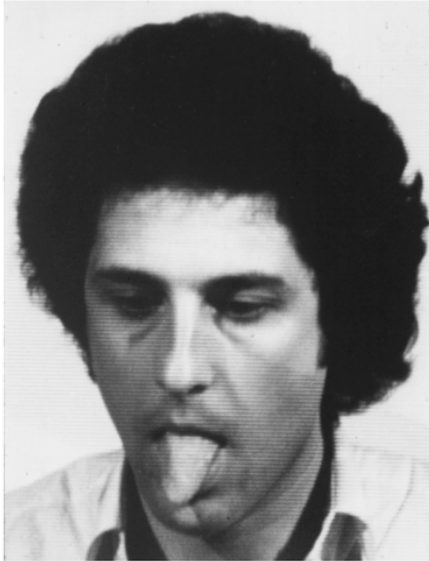
Toward A Better Understanding of Social & Motor Deficits in Children with ASD

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University of Southern California



Imitation



From: A. N. Meltzoff & M. K. Moore (1977). *Science*, 1977, 198, 75-78.

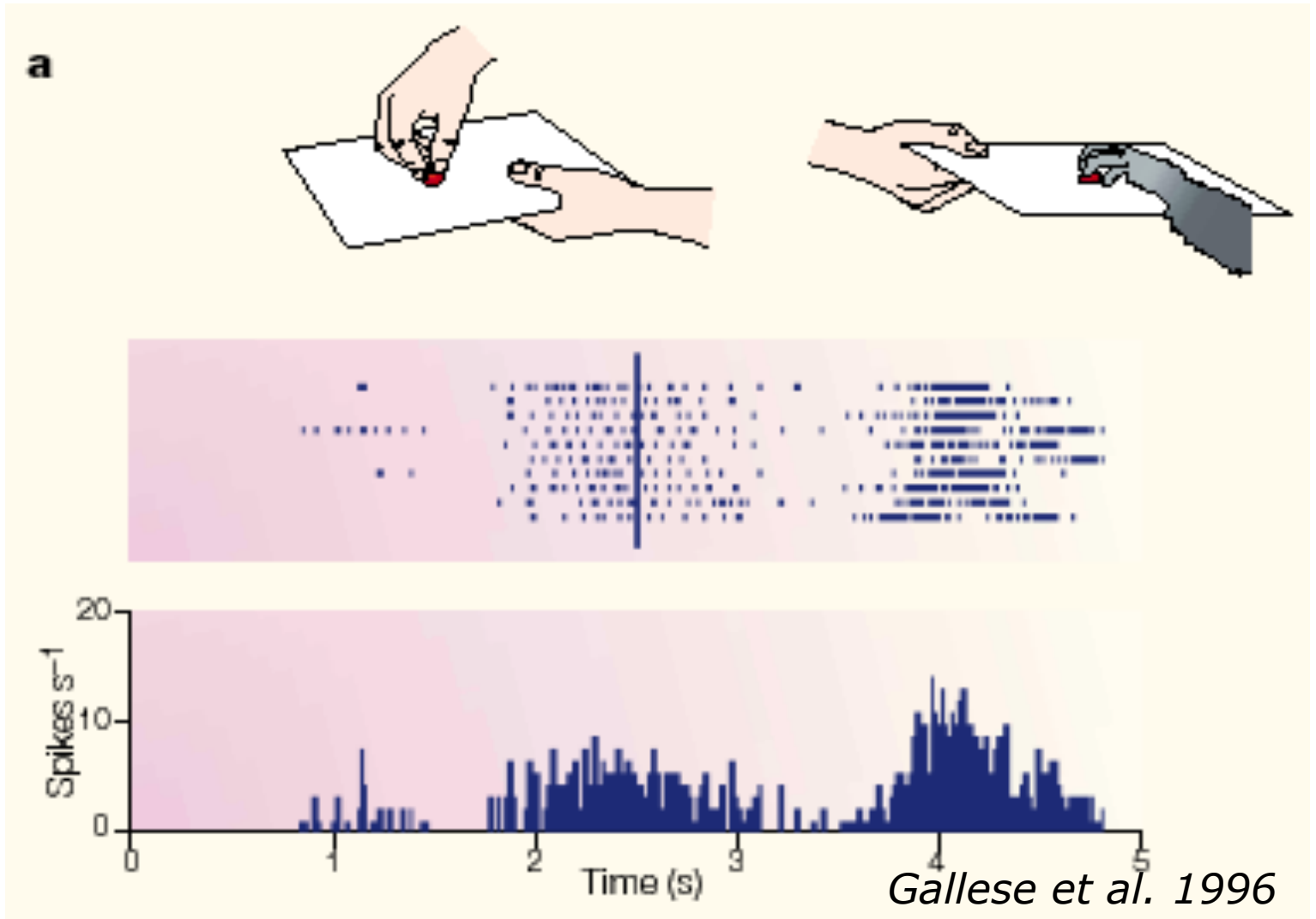
Imitation deficit in ASD?

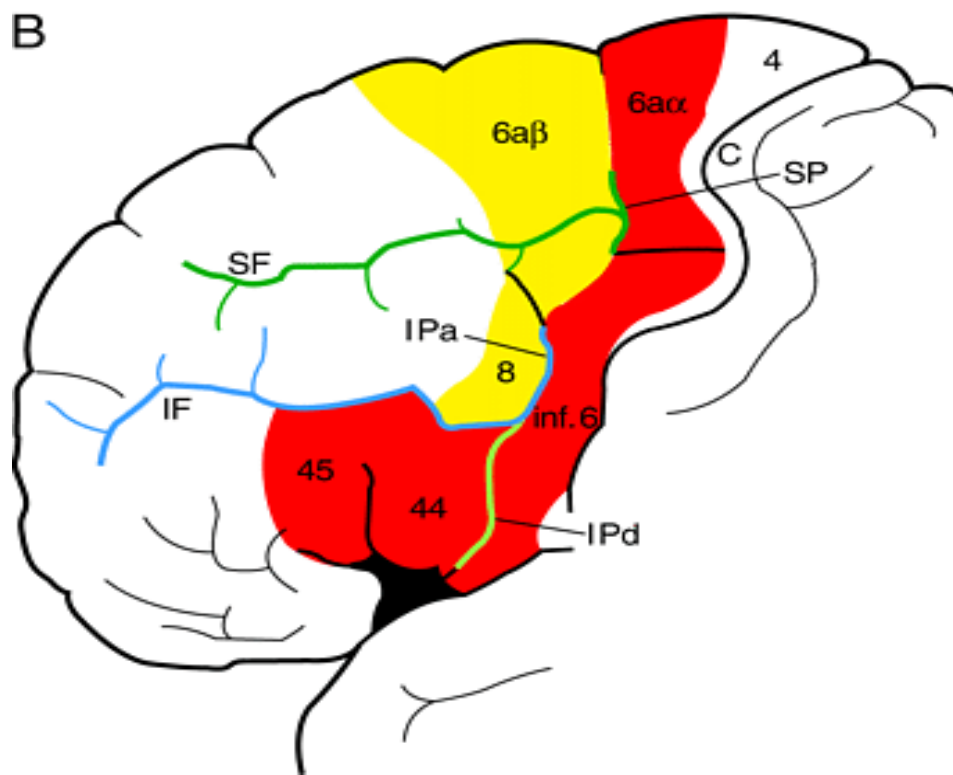
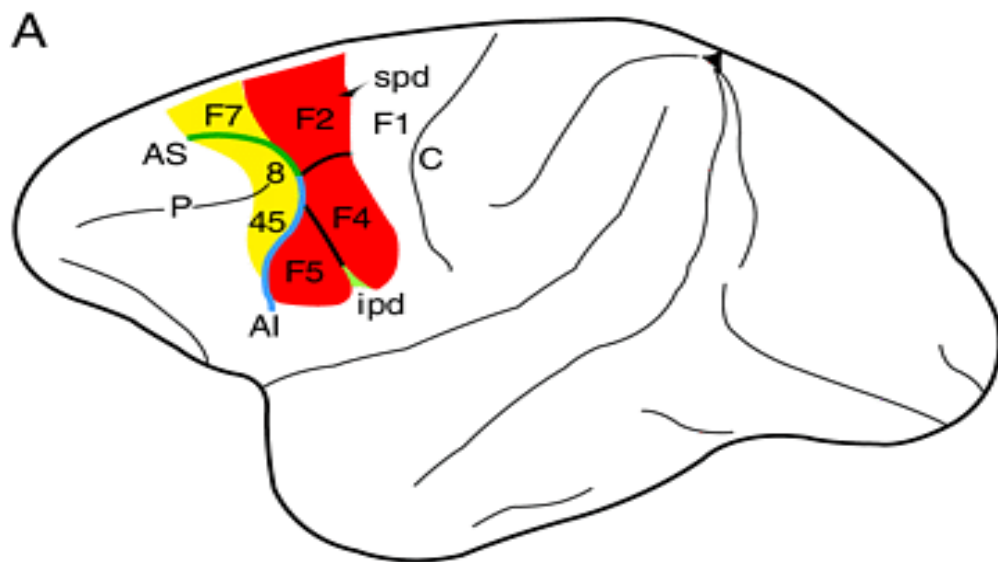


Video by Autism Training Solutions (ATS)

What is the neural basis of imitation?

Mirror Neurons: Area F5

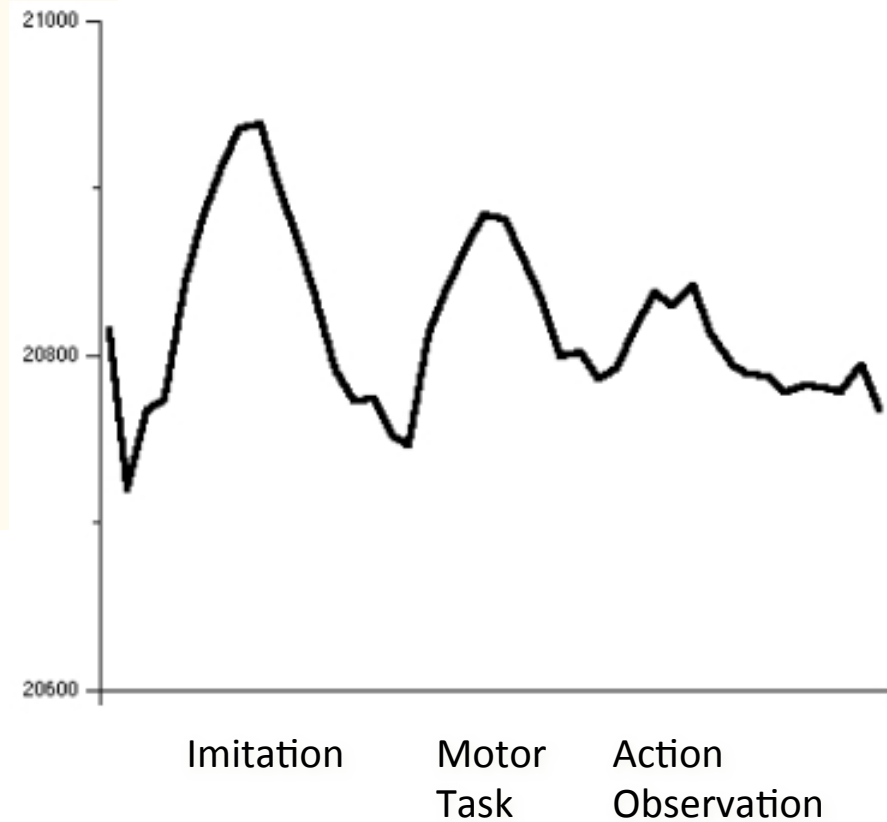
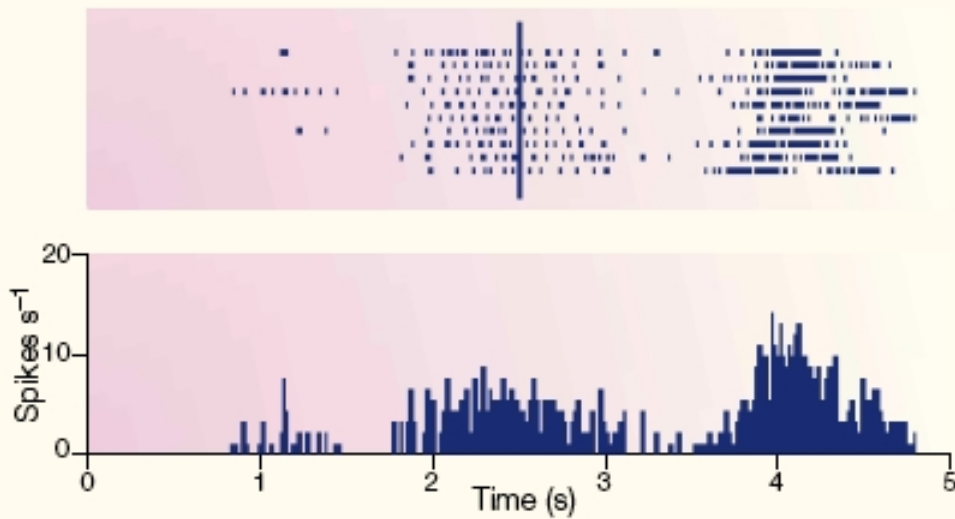
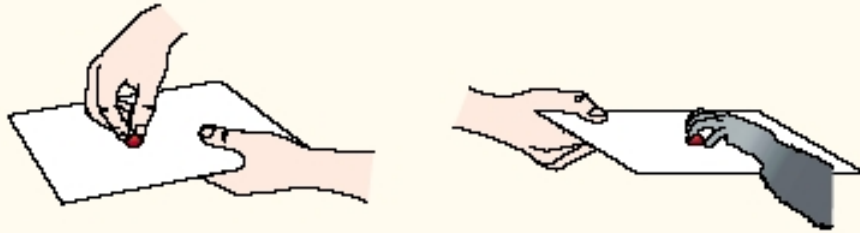


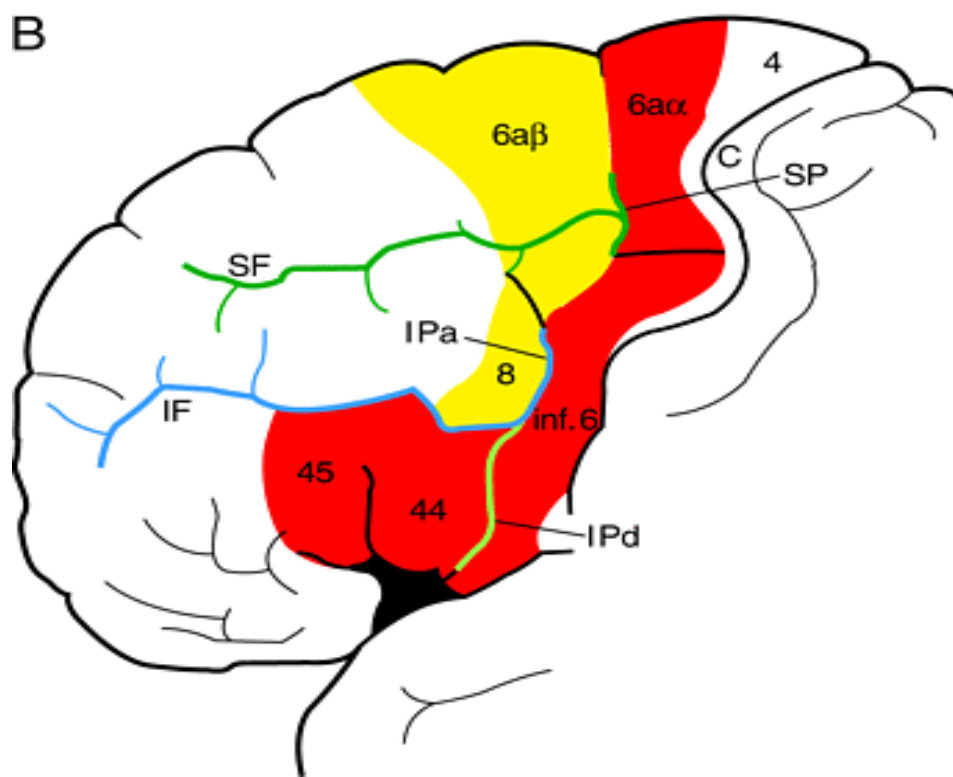
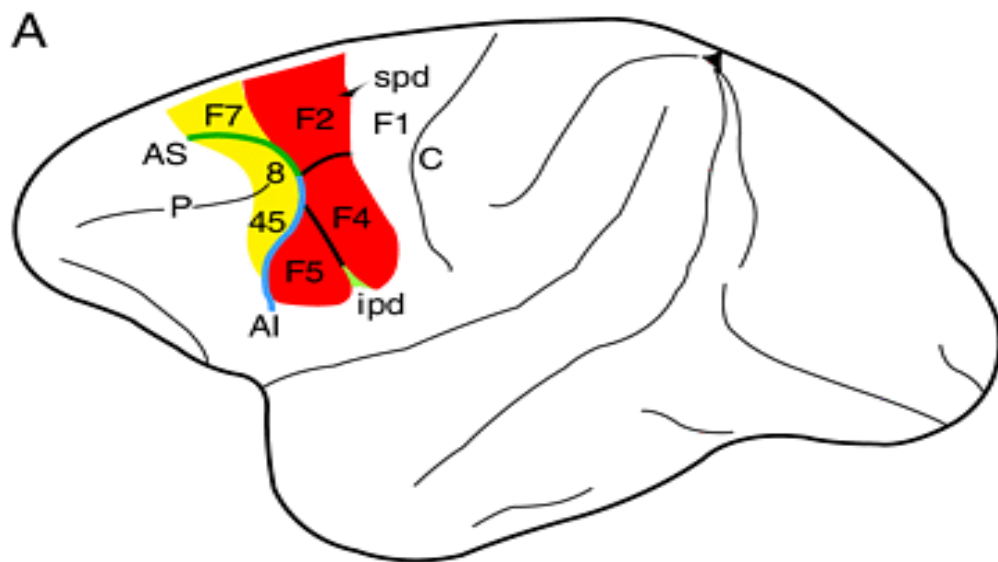




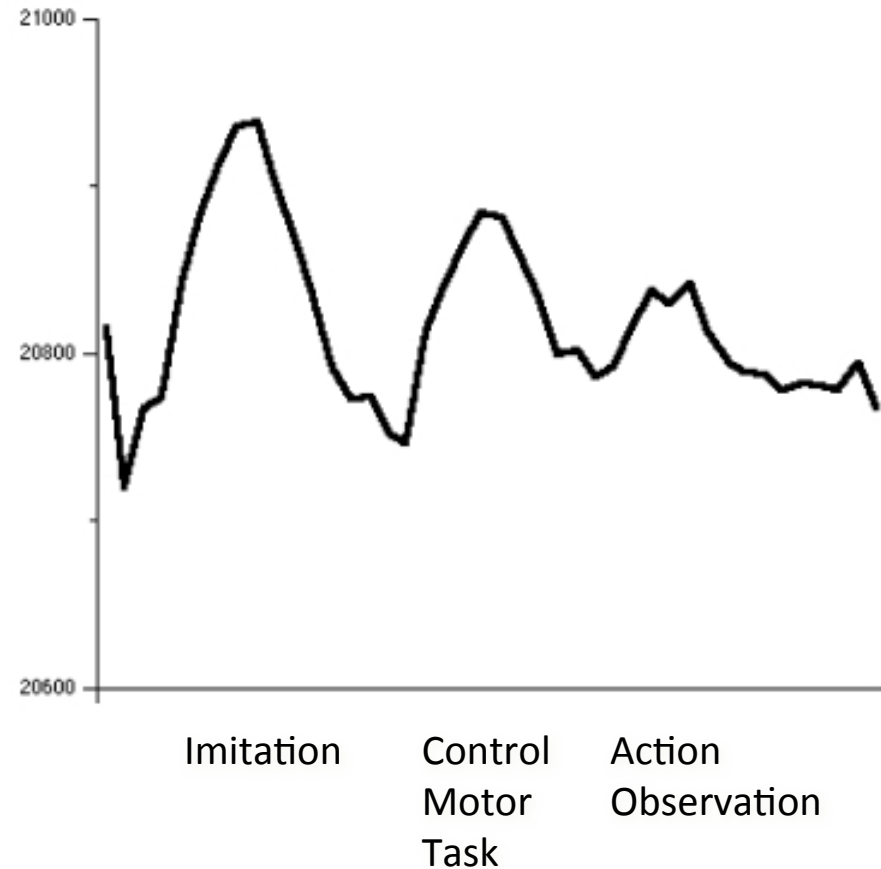
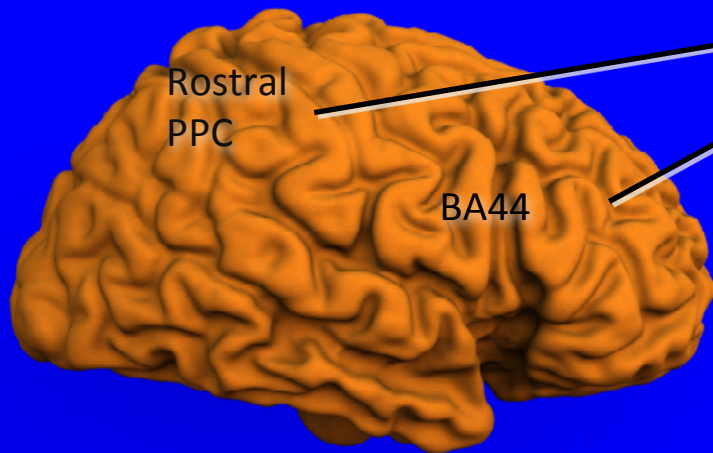
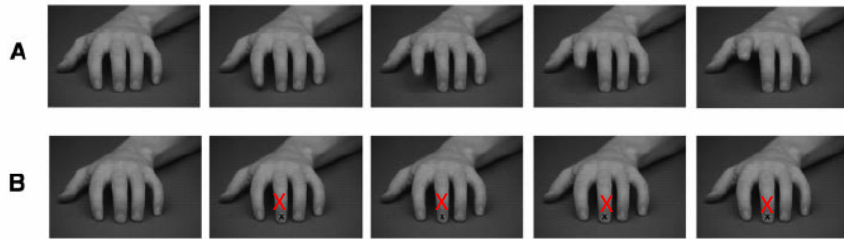
Mirror neurons and fMRI

a



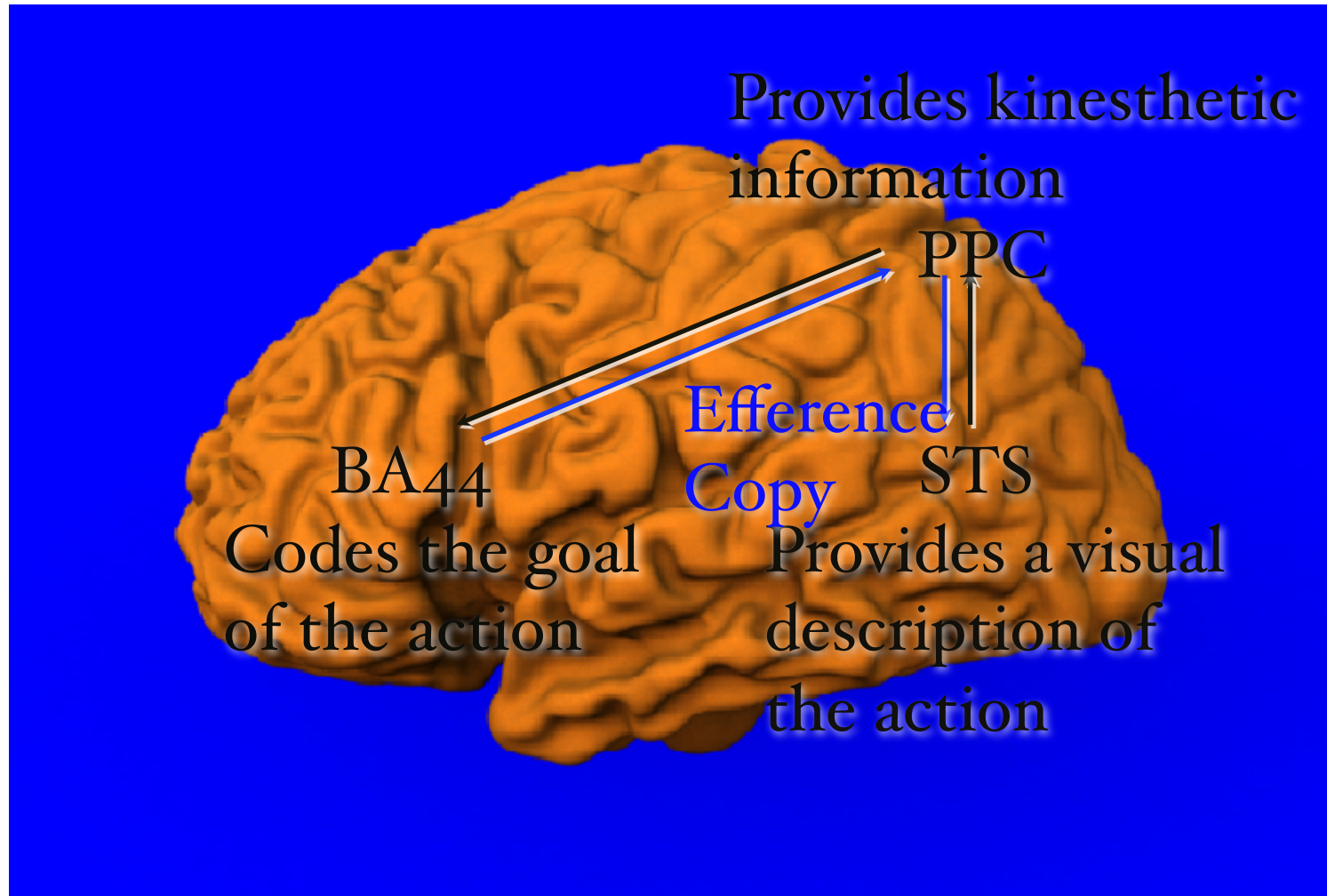


Fronto-parietal human mirror areas for imitation

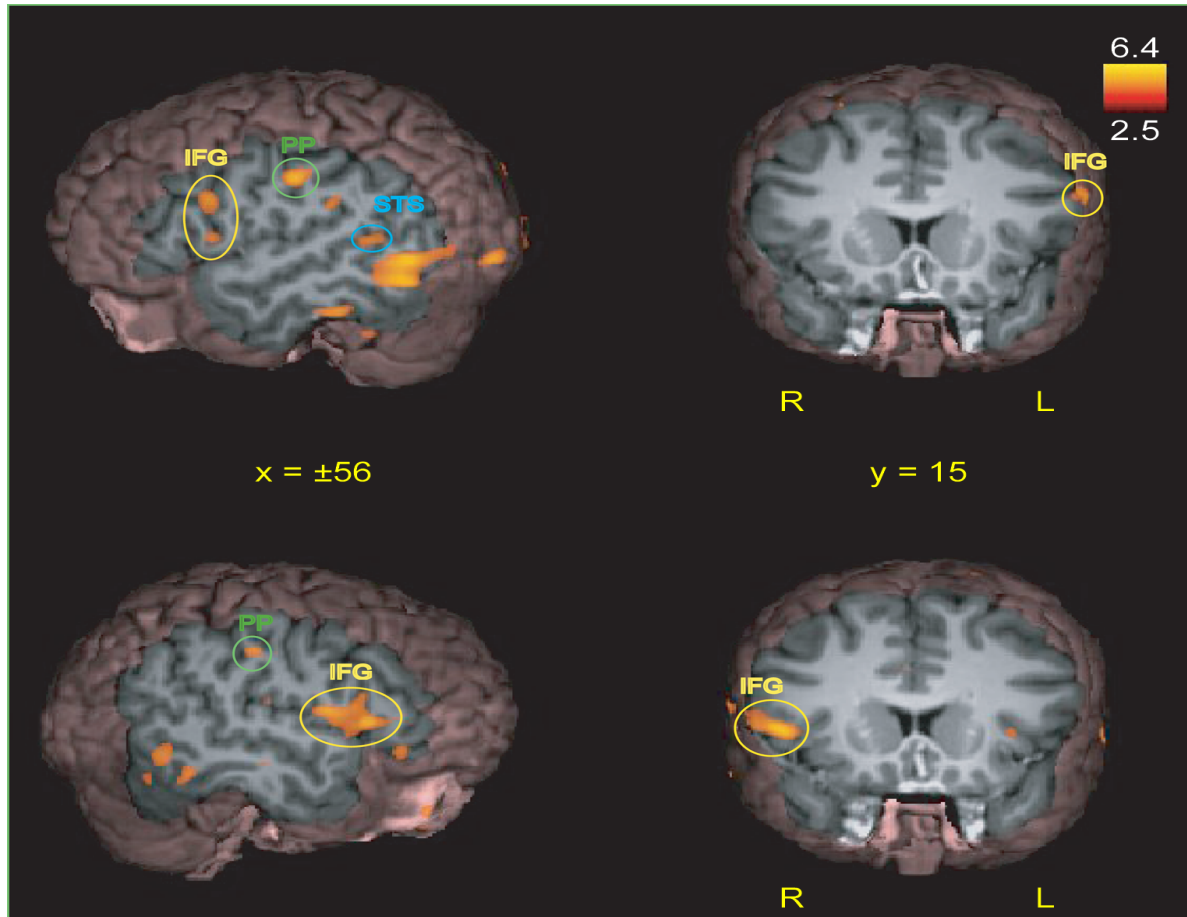


Iacoboni et al., 1999

Neural Architecture for Action Representation

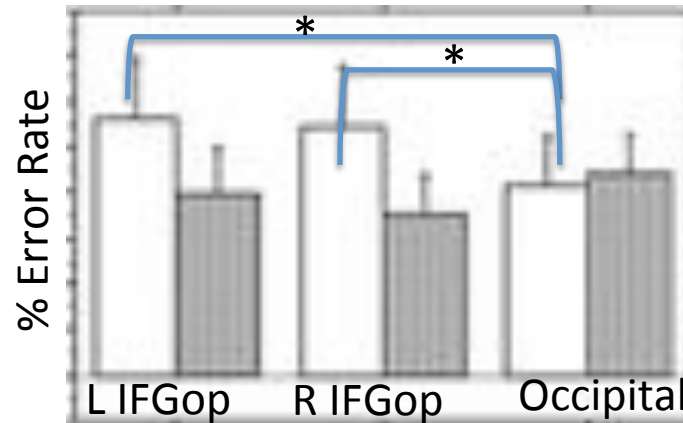
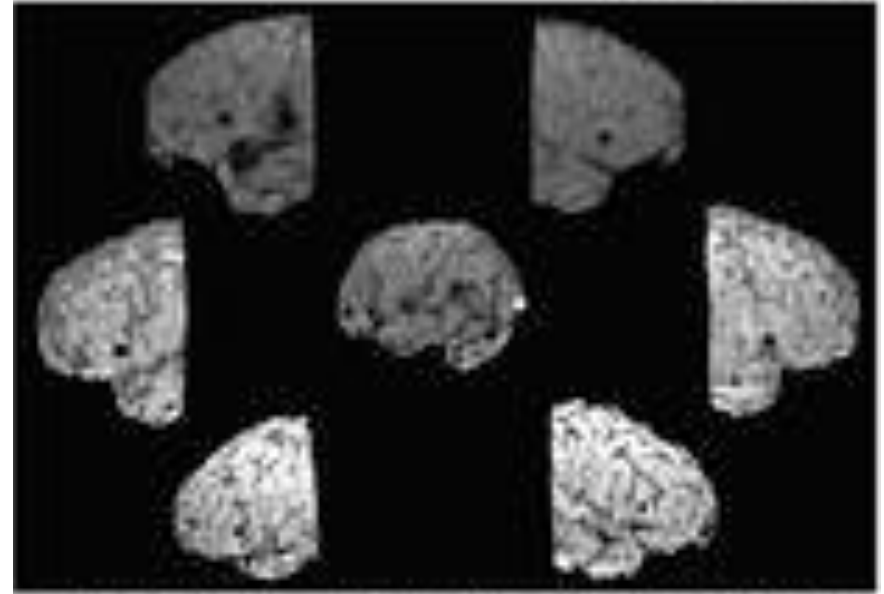


Human visuo-motor mirror neuron system



Aziz-Zadeh et al., 2006

IFG is essential to imitation



Imitation
Control Task

Is there a deficit in the MNS in
Autism?

Imitation of facial expressions inside fMRI scanner



Angry



Fearful



Disgusted



Happy



Sad



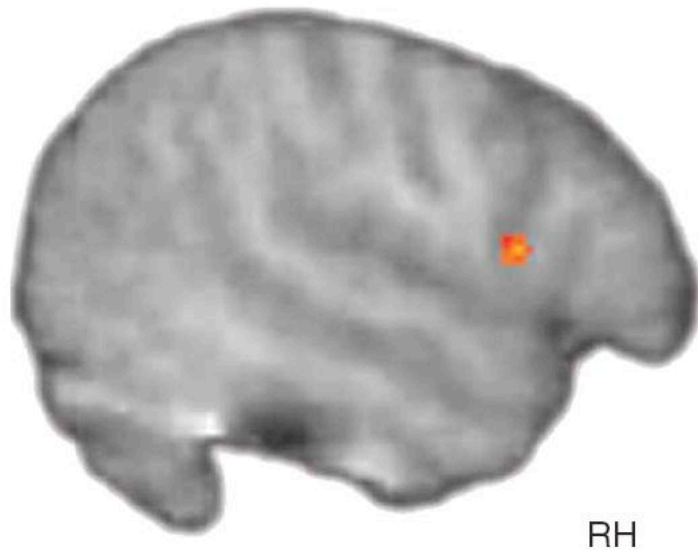
Surprised



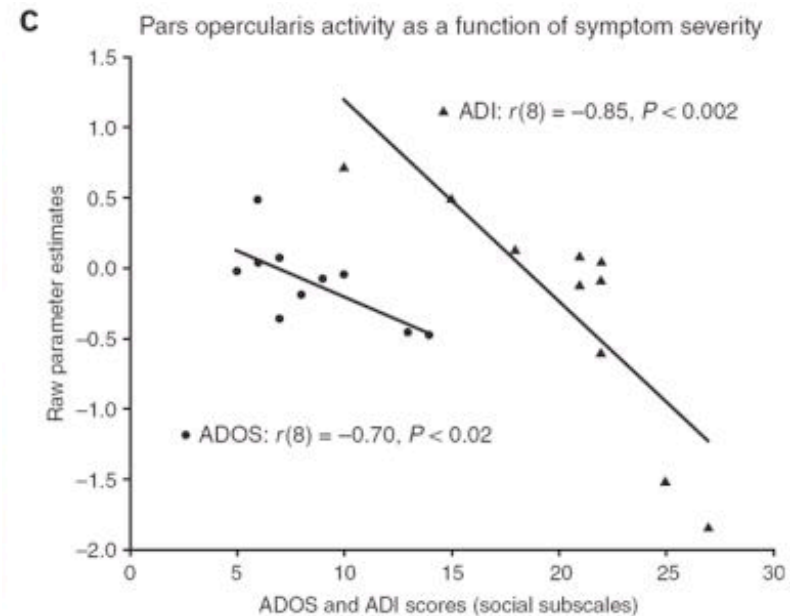
Neutral

Deficit in IFG in children with ASD during facial imitation task

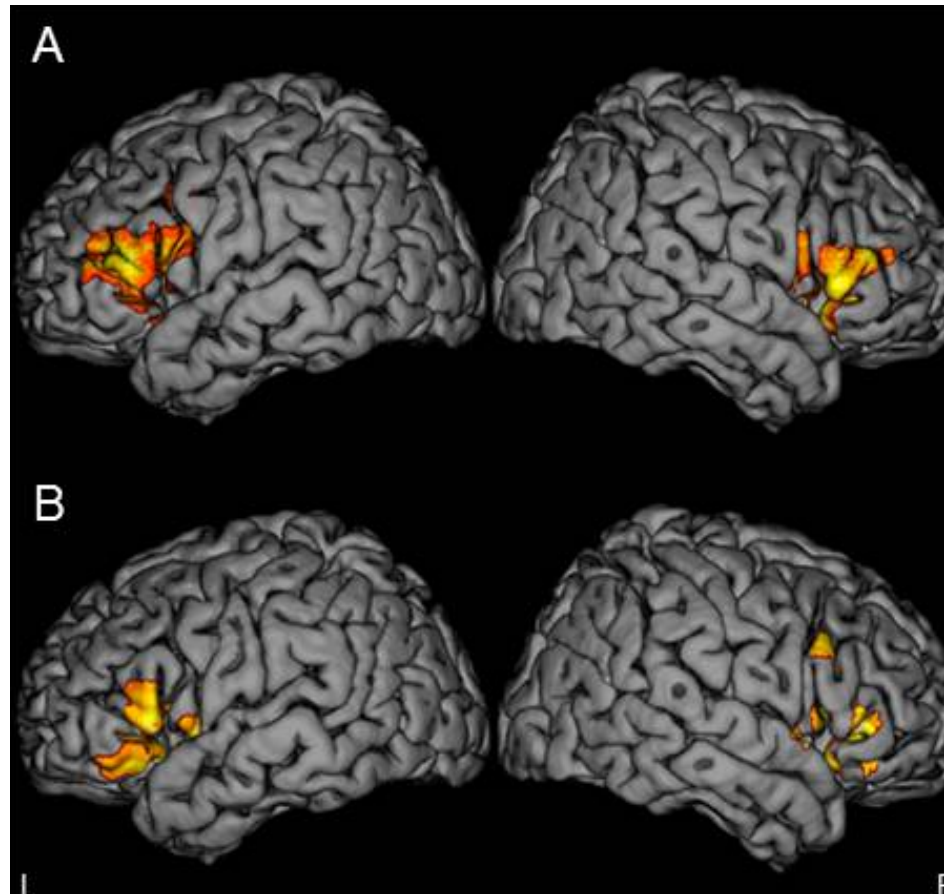
TD>ASD



Correlation with symptom severity



Deficit in IFG of MNS in children with ASD



Correlation with
impairment (ADOS)

TD>ASD during
imitation task

Dapretto et al, prelim data from 40 participants with ASD

Is there an MNS deficit in individuals with imitation impairments in general – not only in autism?

**Developmental Coordination
Disorder (DCD):
A developmental deficit in motor
learning**

DCD

- Disorder of motor learning
- Developmental in nature, but may continue through adulthood
- Generally assessed by imitation ability

Participants

- 28 young adults, 18-30 years old, right-handed

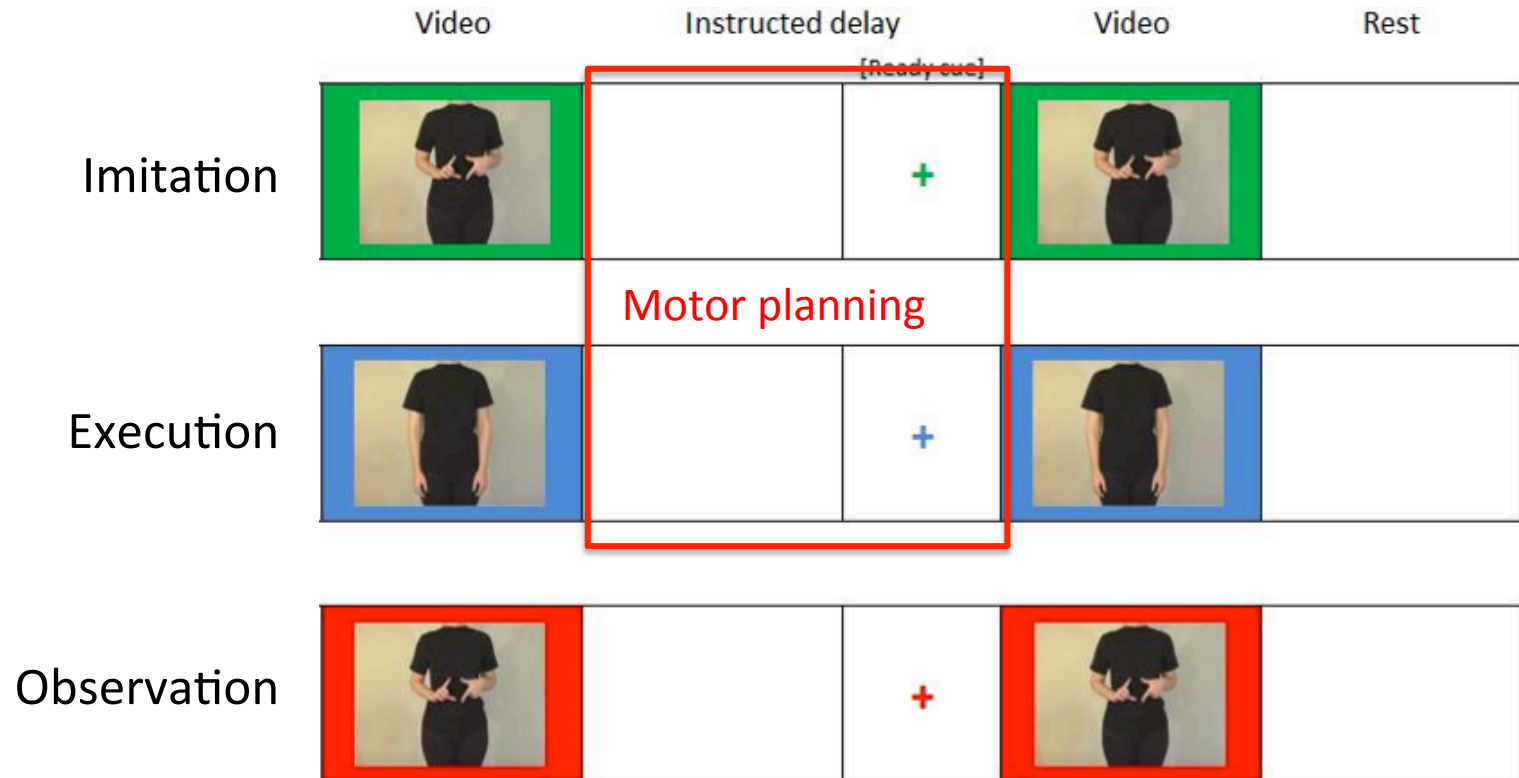
Group 1: Developmental dyspraxia (n=14)

- Stated history of poor motor skills, poor coordination, or “clumsiness”
- Below 15 %ile on SIPT-A Postural Praxis test & BOT-2 Short Form

Group 2: Typically developing (n=14)

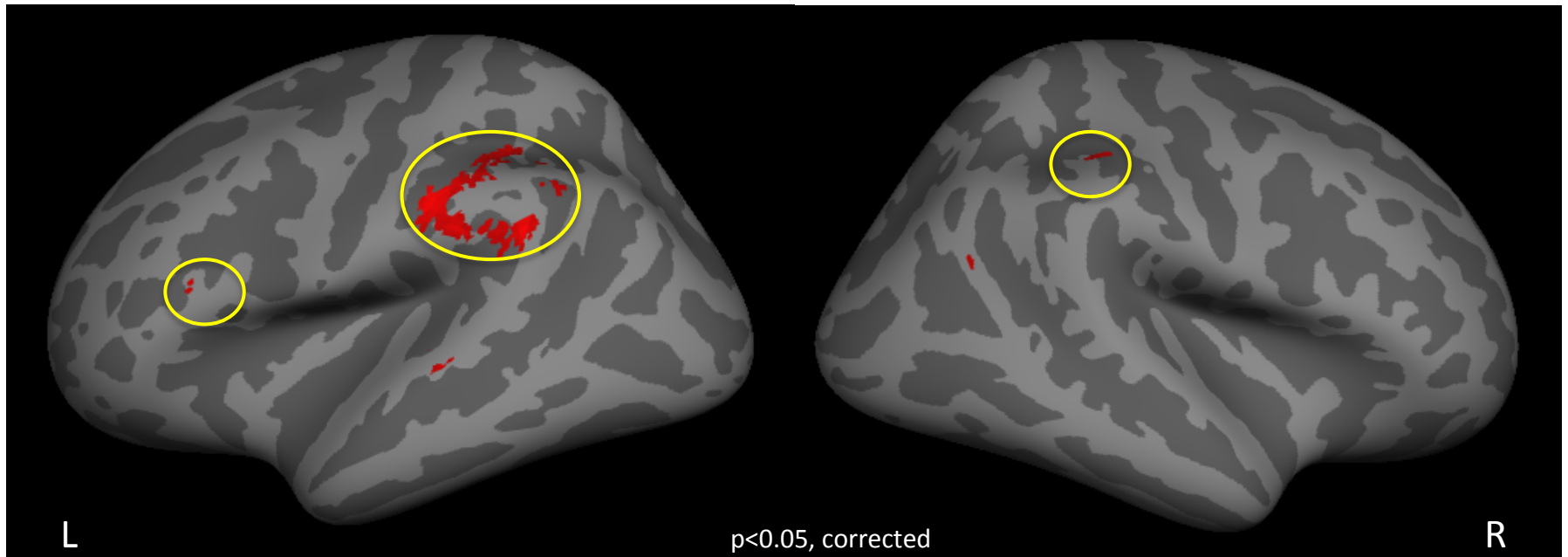
- Age- and gender-matched to dyspraxia group

DCD study design



Imitation

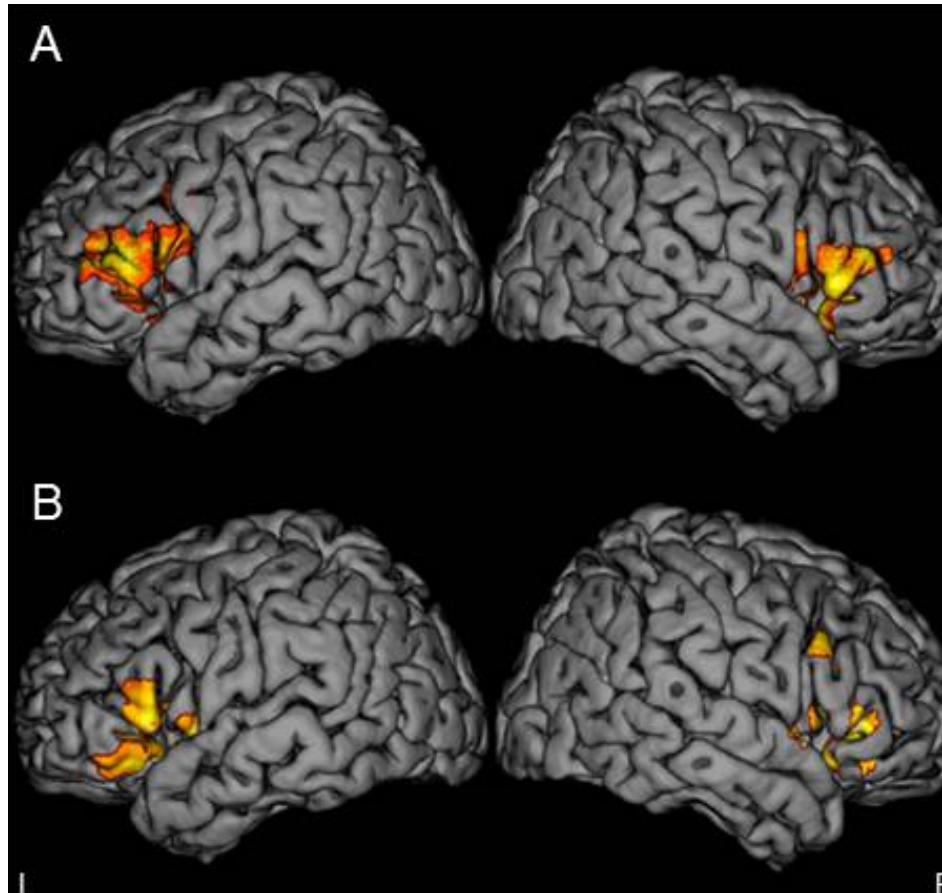
Typically developing (TD) > DCD



Activity for imitation is negatively correlated with impairment (SIPT)



Reminiscent of findings in children with ASD



Correlation with
impairment (ADOS)

TD > ASD during
imitation task

Dapretto et al, prelim data from 40 participants with ASD

Current study:

Compare social and motor brain networks

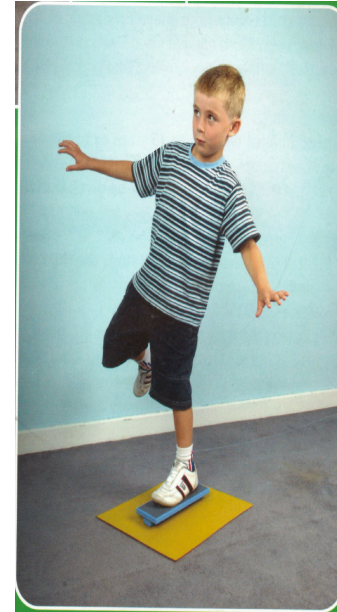
ASD vs. DCD vs. TD

Subjects: 9-15 yo, right handed, English speaking

- **ASD (current N= 13)**
 - a clinical diagnosis of ASD confirmed by the ADOS and ADI-R
 - IQ>80 on the WASI-II
 - The Movement Assessment Battery for Children-2 (MABC-2) used as covariate
- **Individuals with DCD (current N=6)**
 - performance at or below the 15th percentile on the MABC-2 and impaired motor skills as assessed by parent questionnaire
 - no first degree relatives with ASD, no current or previous concerns about an ASD diagnosis
 - The SRS-2 administered to assess social ability and used as a covariate
- **Age- and Gender-Matched TD Controls (current N=16)**
 - performance at or above the 25th percentile on the MABC-2
 - no first degree relatives with ASD or DCD, no current or previous concerns about an ASD diagnosis, and a score of T<60 on the SRS-2

Movement Assessment Battery for Children -2 (MABC-2)

- Manual Dexterity
 - Turning Pegs
 - Triangle with Nuts and Bolts
- Aiming and Catching
 - Catching Ball
 - Throwing Ball
- Balance
 - Walking Toe-to-Toe
 - Hopping
 - Balance Board



Social Responsiveness Scale (SRS)

Not True, Sometimes True, Often True, Almost Always True

1. Avoids eye contact tor has unusual eye contact
2. Recognizes when something is unfair
3. Thinks or talks about the same thing over and over
4. Is regarded by other children as odd or weird

Study Demographic Information

Group	Age	Sex	IQ	MABC-2	SRS
TD N= 16	11.25 ± 1.39	4 female	111.44 ± 12	11 ± 1.75	45.5 ± 4.94
ASD N= 13	11.05 ± 1.68	3 female	98.62 ± 24.38	6.09 ± 3.17	76.54 ± 8.22
DCD N= 6	10.79 ± 1.22	1 female	106.17 ± 20.52	4.67 ± 1.36	57.83 ± 9.7

Design

- Day 1: Assessments & MRI Desensitization
- Day 2: fMRI, MRI



fMRI task

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	Hand Actions	Face Non-Emotional	Face Emotional
Action Observation: <i>"Watch the following videos closely"</i>	1. Cut with scissors 2. Salt food 3. Open can of soda 4. Stir with spoon 5. Cut sandwich 6. Spread on sandwich 7. Pencil to write 8. Key to unlock door	1. Tongue to upper lip 2. Tongue around 3. Jaw out 4. Puff one cheek 5. Teeth over lips 6. Wriggle nose 7. Bite lower lip/ upper lip 8. Close one eye	1. Happy 2. Sad 3. Angry 4. Surprised 5. Fear 6. Anxiety 7. Disgust 8. Shame
Action Execution: <i>"Perform the predetermined actions when cued"</i>	Pantomime: salt food or stir with spoon when cued by a still image of hand	Perform: tongue to upper lip or puff cheek when cued by a still image of a face with a blue frame	Perform: happy or sad expression when cued by a still image of a face with a red frame
Imitation: <i>"Imitate what you see the actor do"</i>	Same stimuli as observation (pantomime without objects)	Same stimuli as observation	Same stimuli as observation
Intention Understanding <i>"Think about why the actor is making this action/face/emotional expression"</i>	Same stimuli as observation (e.g., 1. "He wants to make an art project"; 2. "He likes salty food")	Same stimuli as observation (e.g., 1. "He wants to make a funny face"; 2. "His lips are dry")	Same stimuli as observation (e.g., 1. "It is his birthday"; 2. "He lost his favorite toy car.")

fMRI Task

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	<i>Hand Actions</i>	<i>Face Non-Emotional</i>	<i>Face Emotional</i>
Action Observation: <i>"Watch the following videos closely"</i>	1. Cut with scissors 2. Salt food 3. Open can of soda 4. Stir with spoon 5. Cut sandwich 6. Spread on sandwich 7. Pencil to write 8. Key to unlock door	1. Tongue to upper lip 2. Tongue around 3. Jaw out 4. Puff one cheek 5. Teeth over lips 6. Wriggle nose 7. Bite lower lip/ upper lip 8. Close one eye	1. Happy 2. Sad 3. Angry 4. Surprised 5. Fear 6. Anxiety 7. Disgust 8. Shame
Imitation: <i>"Imitate what you see the actor do"</i>	Same stimuli as observation (pantomime without objects)	Same stimuli as observation	Same stimuli as observation



Emotional Face

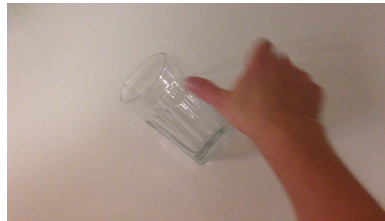
Task Design

Stimuli Conditions

Emotional Faces

Non Emotional Faces

Hand Actions



TR = 2s

Video Block
(4 videos)

Resting
Block

3.75 s

+

3.75 s

+

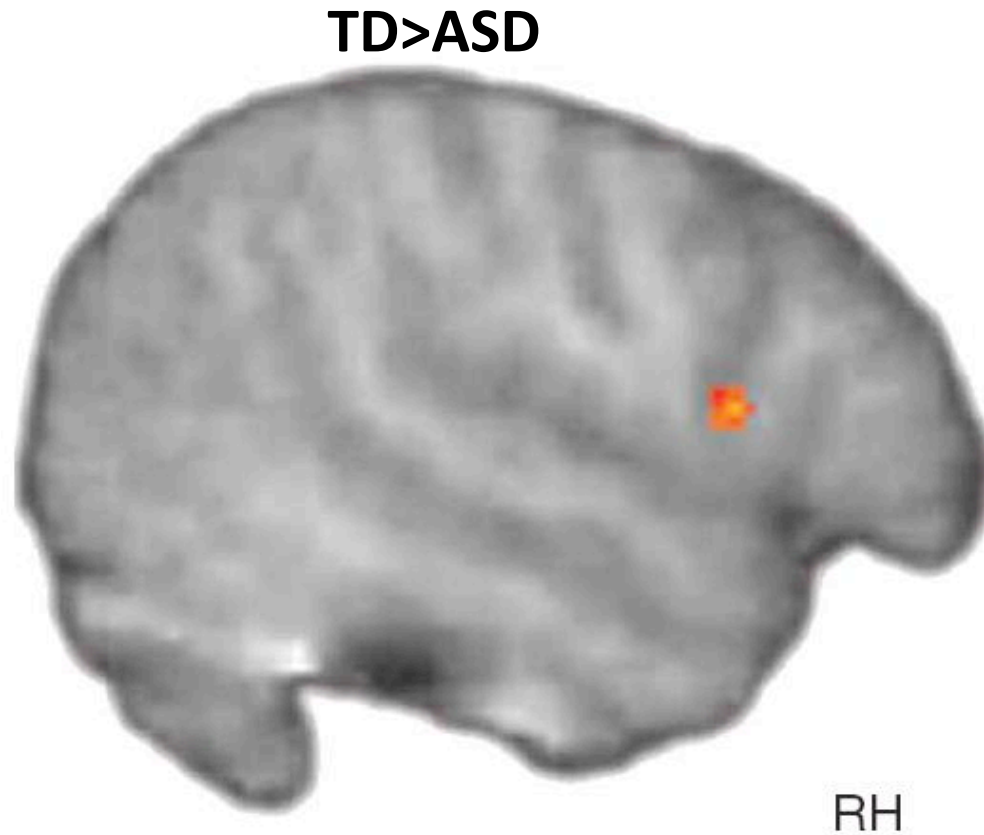
15 s

Action observation: "watch video"

Imitation: "Imitate what you see the actor do"



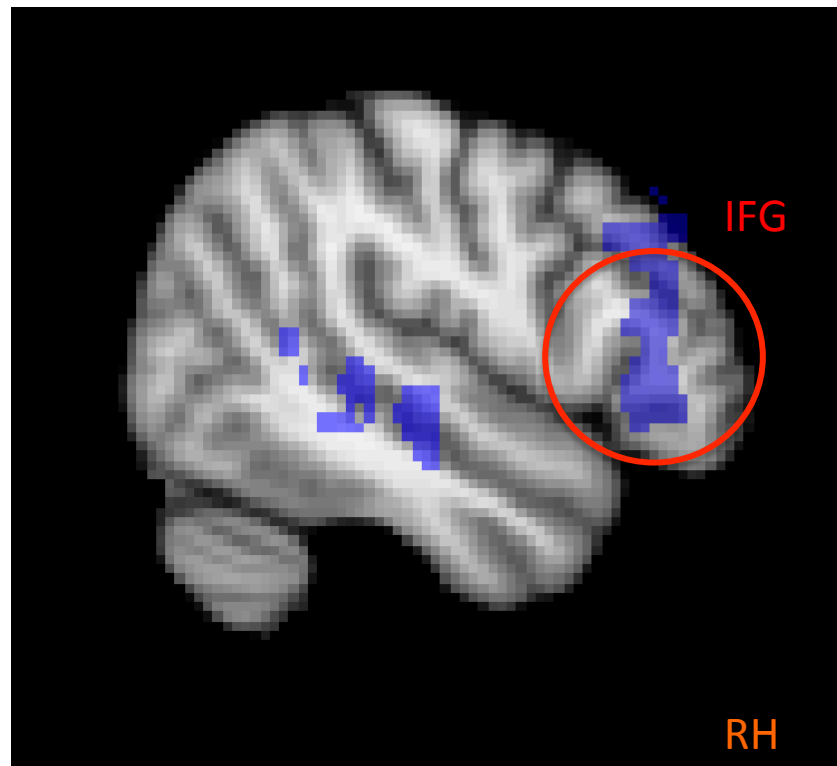
Deficit in IFG in children with ASD during facial observation task



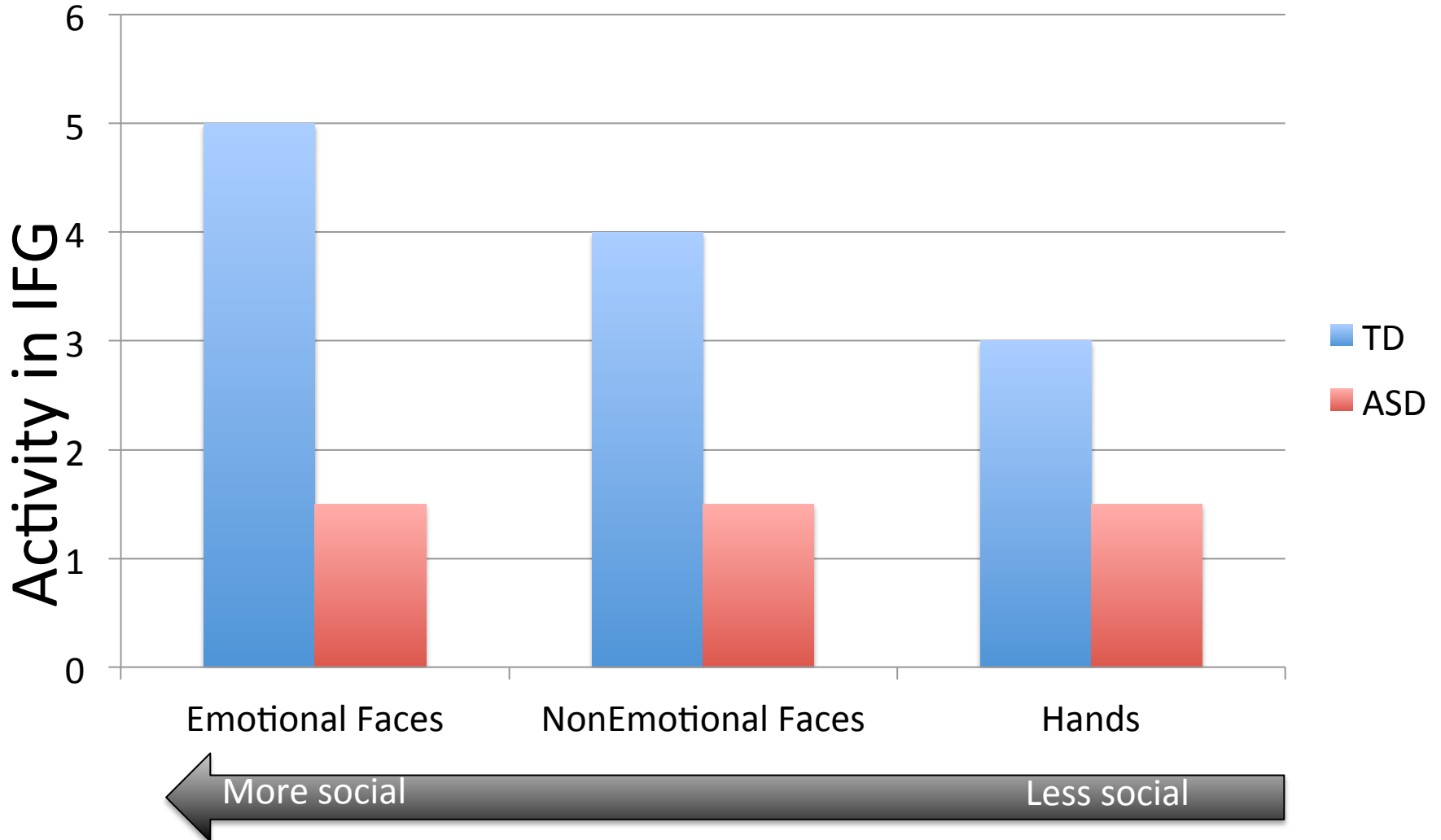
Dapretto et al., 2006

Can we replicate deficit in IFG in kids with ASD?

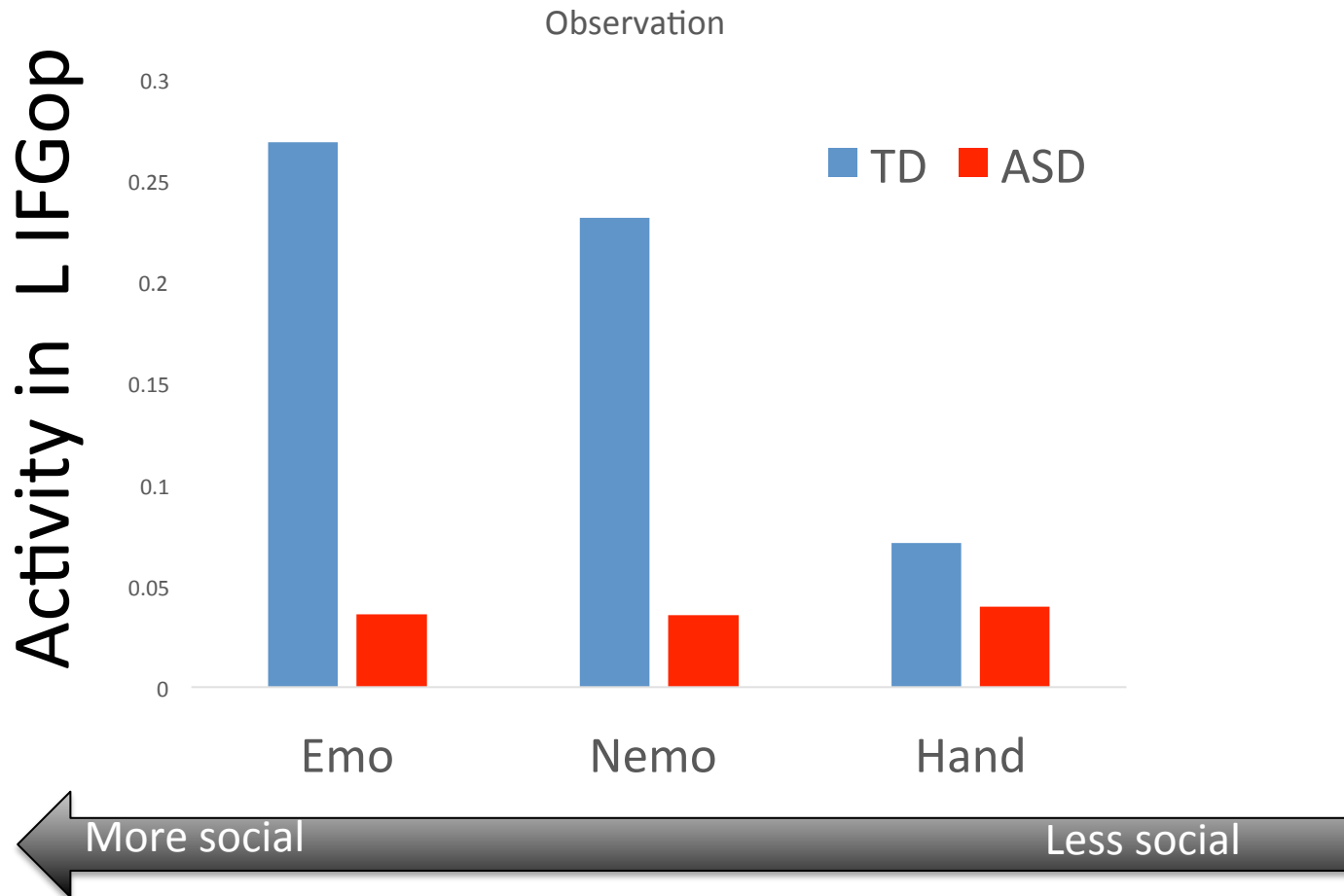
TD > ASD



Predicted Results



IFG deficit in kids with ASD during action observation

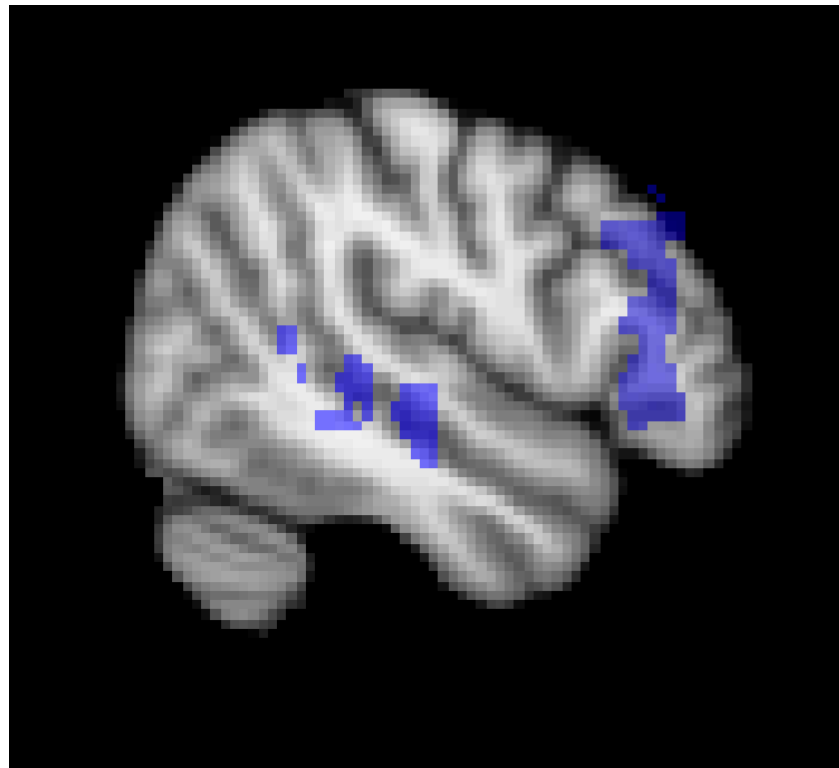


TD and DCD compared to ASD

show more activity in frontal motor regions
during action observation

TD > ASD

DCD > ASD

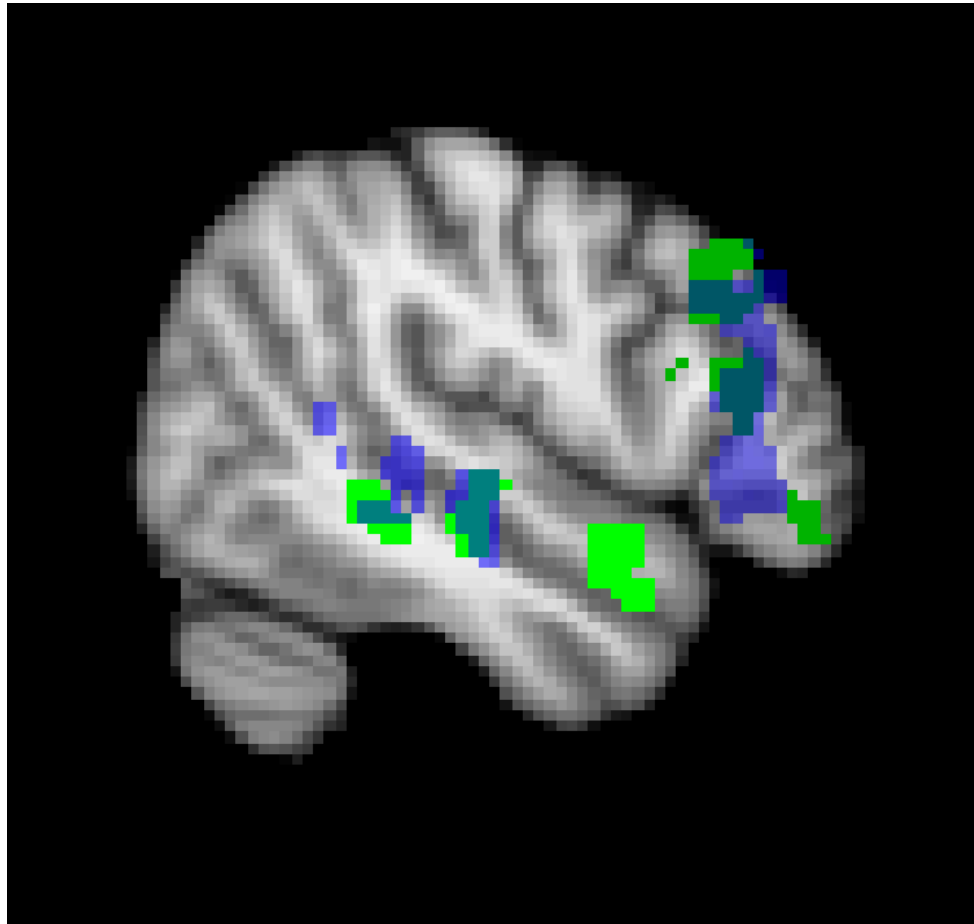


TD and DCD compared to ASD

show more activity in frontal motor regions

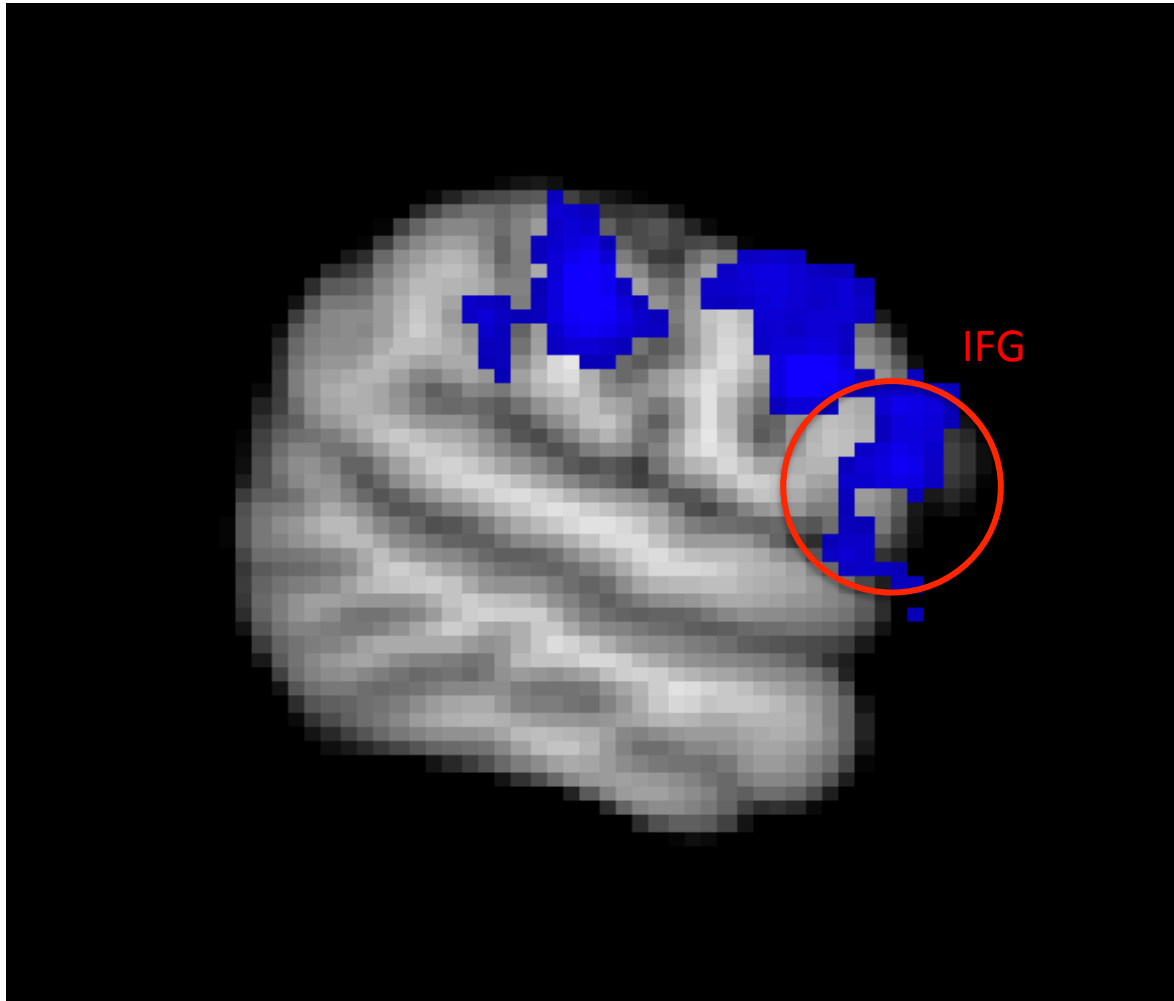
TD > ASD

DCD > ASD

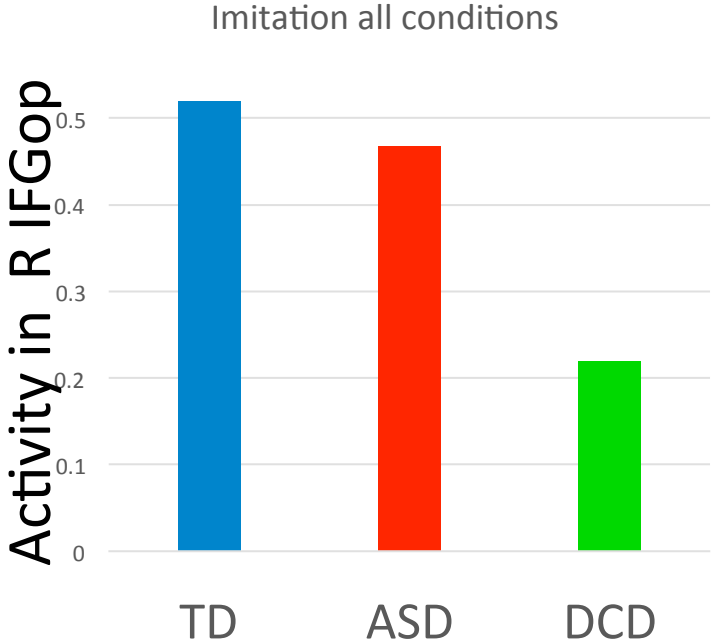
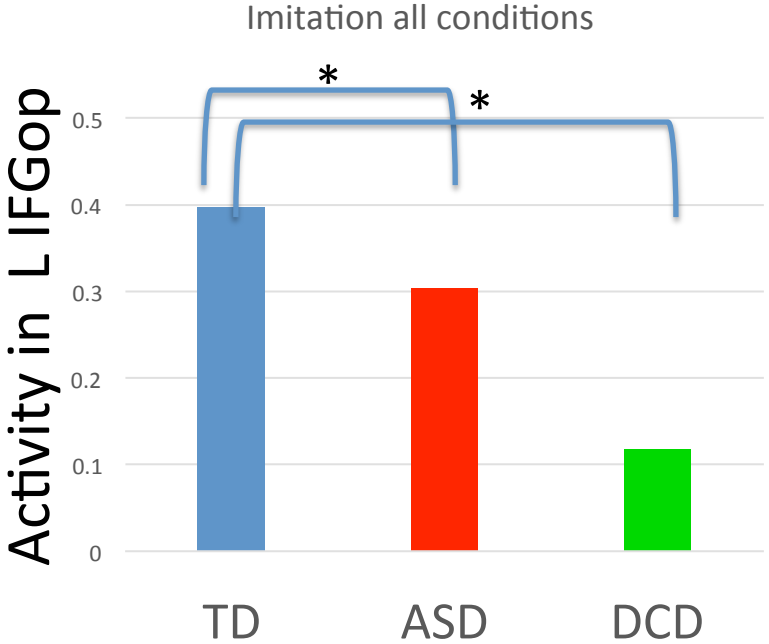


What about for imitation?

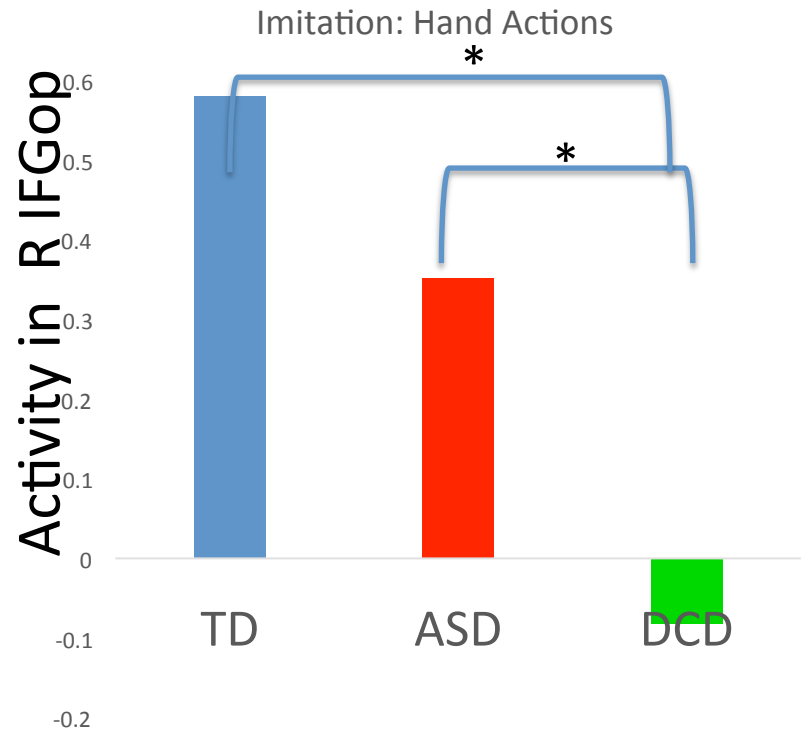
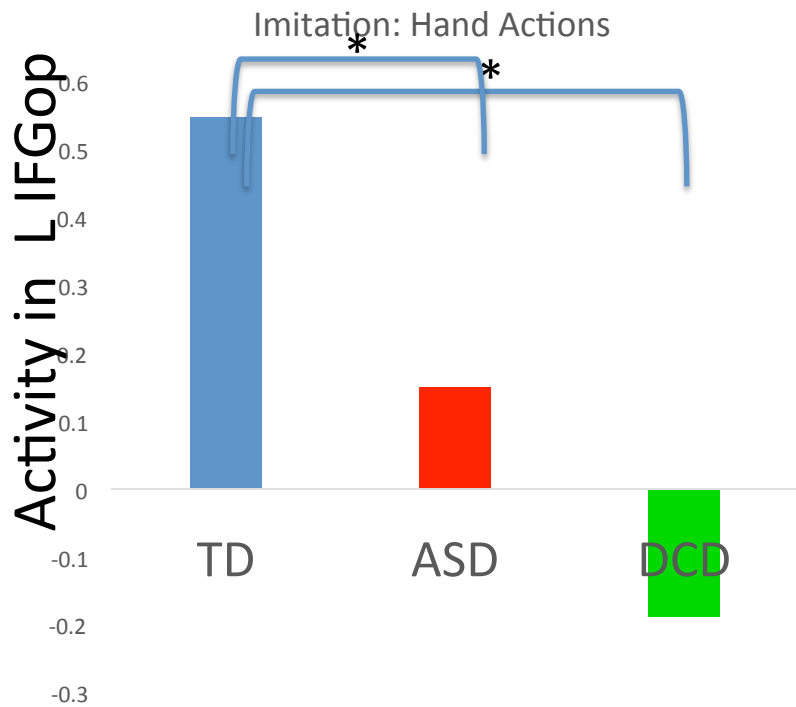
Imitation: Emotional Faces TD>ASD



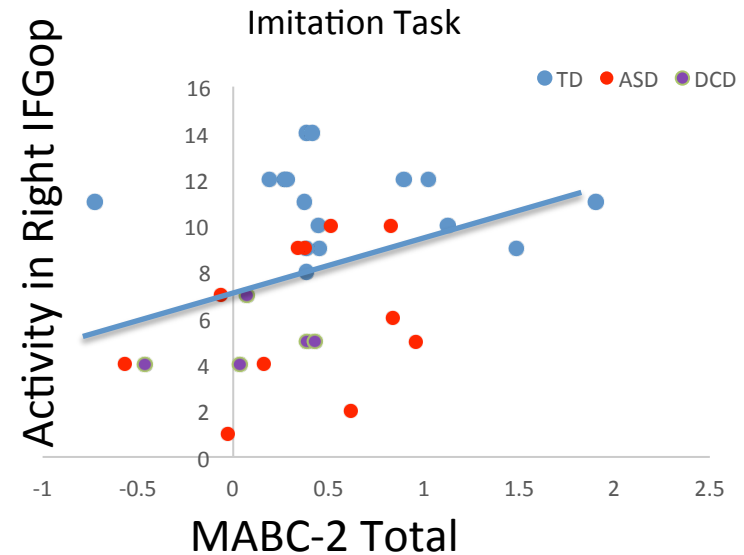
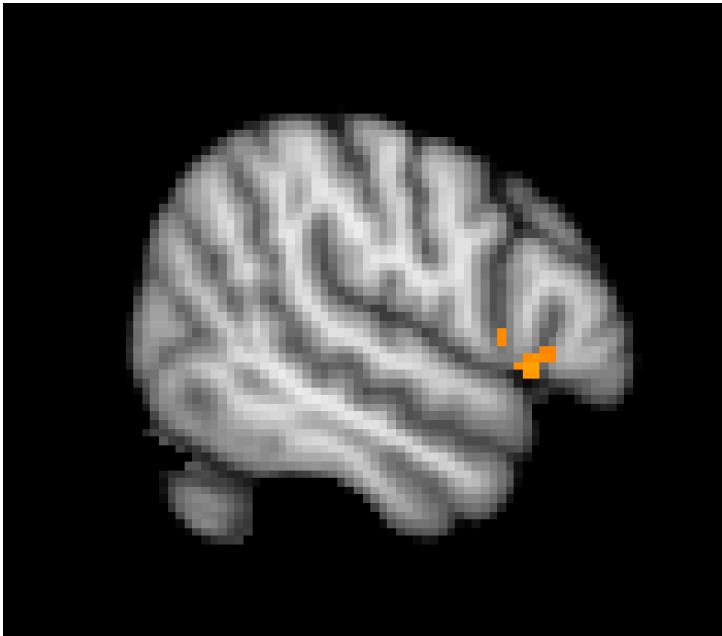
IFG deficit in ASD and DCD during imitation



Imitation Hand Actions: TD, ASD, & DCD



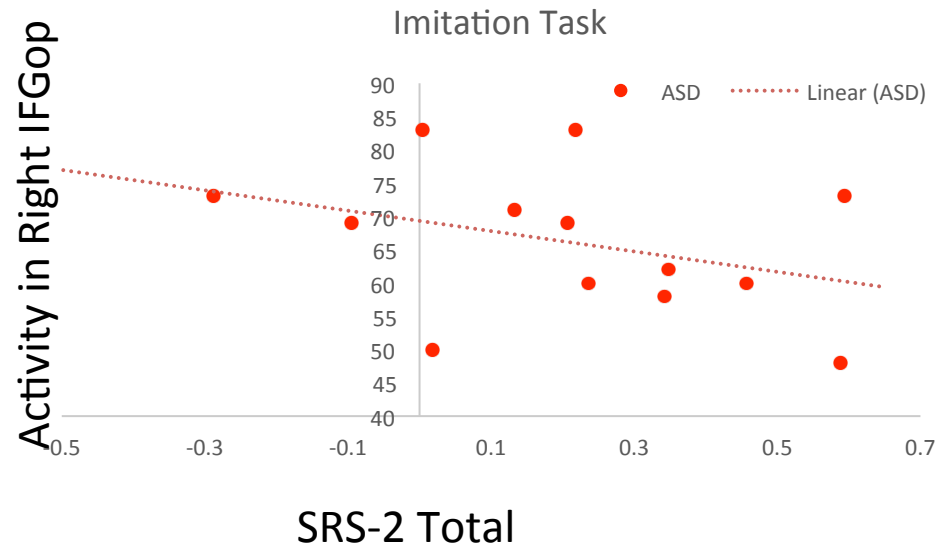
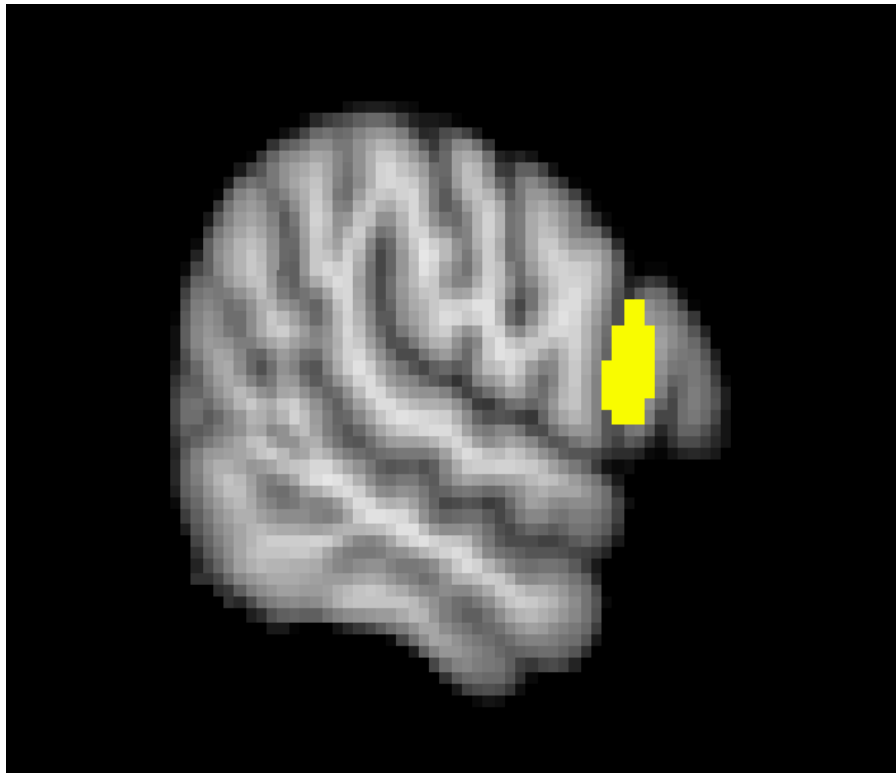
Activity in IFG is correlated with motor ability during imitation task



Across groups $r=.352$, $p = .045$

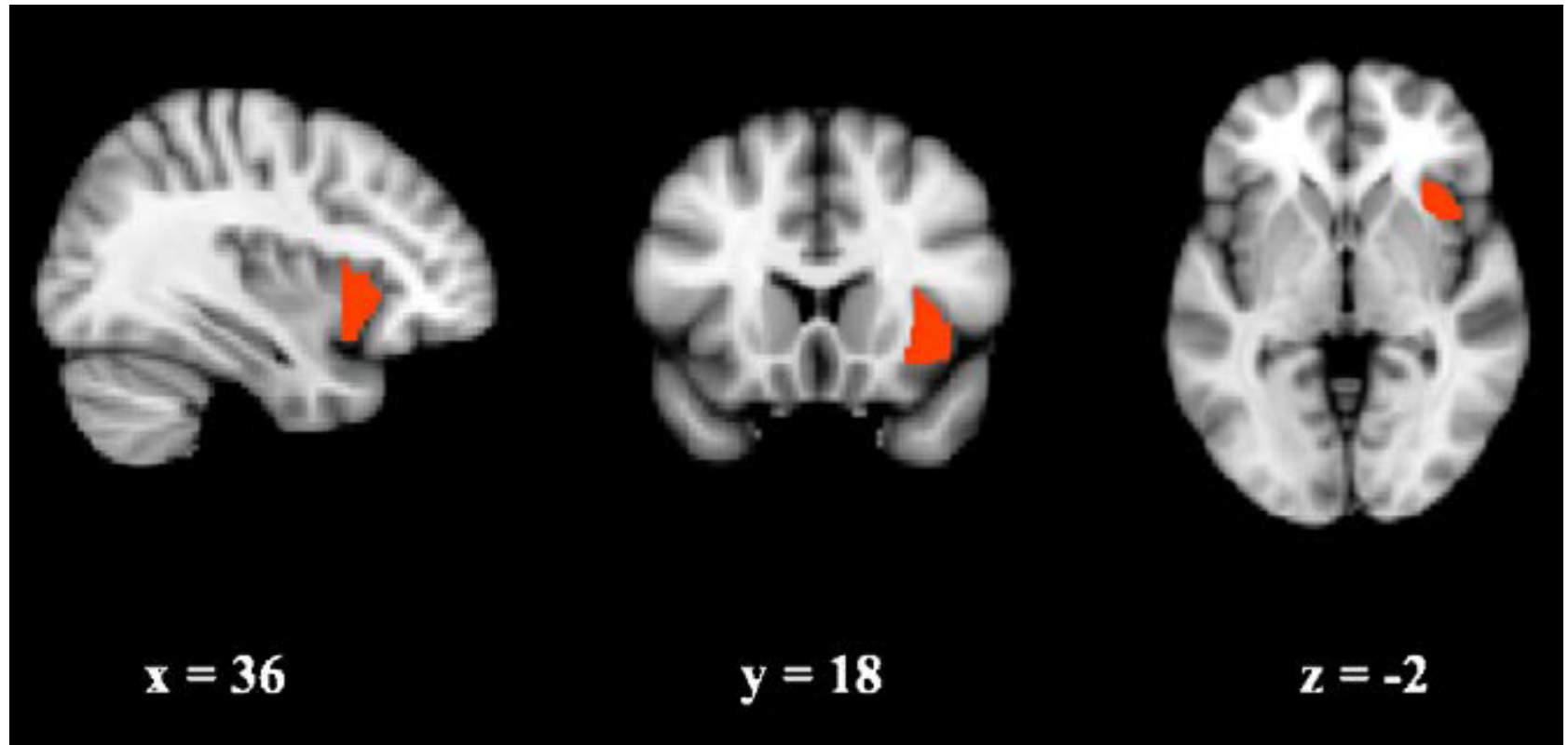
What is specific for emotional faces in ASD?

For children with ASD, activity in the rIFG is correlated with social ability when imitating emotional faces



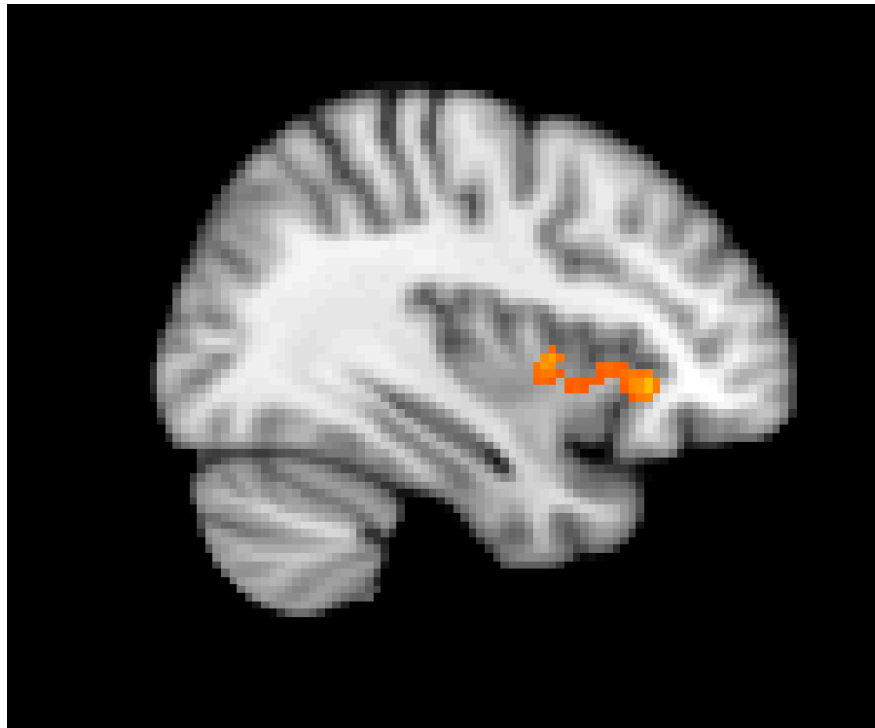
ASD $R=-.689$, $p=.009$

Moving beyond the MNS to Emotion Regions: Right Anterior Insula hypoactive in ASD



Di Martino et al. (2009): across 24 studies examining social processing (e.g., face processing, theory of mind) aINS consistently showed significant hypoactivity in ASD.

Anterior insula activity during imitation is correlated with both social and motor ability (SRS-2 / MABC2)



Correlation with social ability (SRS2)



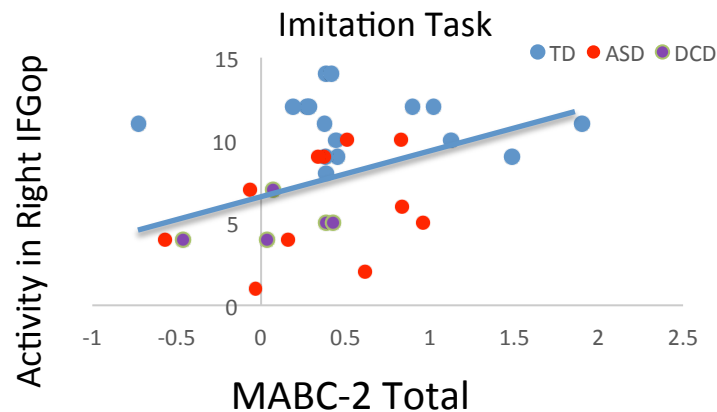
Correlation with motor ability (MABC2)

Summary

- Motor regions are less active in ASD during observation and imitation
- During imitation, activity in motor regions correlates with motor ability across groups
- For children with ASD, during imitation, activity in motor regions is also correlated with social ability
- During imitation, activity in emotion regions (anterior insula) is correlated with social and motor ability

Future Directions

- More subjects, more analyses
- Connectivity analyses with theory of mind regions, other emotion regions
- Analyze structural brain data
- We may be able to distinguish subgroups of ASD based on motor ability



- Could offer individualized forms of imitation therapy

Imitation Therapy



Video by ATS

Long-term Goal: Individualize therapy for those with imitation deficits

Acknowledgements

- NICHD R01 grant
- Our participants
 - USC
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 - Susan Bookheimer
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 - Liz Goo
 - Cristin Zeisler
 - Vanessa Yu
 - Daisy Duong
 - Jessie Tien
 - Sharada Krishnan
 - Yushi Wang
 - Gina Gosparini
 - Ana Conteir
 - Yaling Yang

**Do you know a
child who would
be interested in
participating?**



Please contact us at:

Chan.usc.edu/minds ~ AZLab@usc.edu ~ (424) 888-2543

Your child can earn \$150 and get a picture of their brain!



Motor
Interpersonal
Neuroimaging
Developmental
Study

Thank you!

